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REVIEWS.

Correlation Papers. The Newark System. By ISRAEL COOK RUSSELL. Bulletin 85, U. S. Geological Survey. Washington, 1892.

THIS Bulletin adds another number to the list of invaluable correlation papers, prepared especially for the Geological Survey, but of the greatest service to all professional geologists and advanced students alike. Prof. Russell's paper is of exceptional completeness from the bibliographical side; its index is a marvel of minute reference; every author's name is followed by a complete list of his writings, the more important ones being analyzed; every locality noticed in any paper is indexed separately, with reference to the place of its mention; occurrences of sandstone, shale, conglomerate and trap are catalogued under these headings. Immediate reference may thus be made to any desired item concerning the Newark system, excepting the fossils, which, for some reason, are not indexed under their names, but only through the authors who have described them.

The chief headings of the text are: Nomenclature, area, lithology and stratigraphy, conditions of deposition, life records, associated igneous rocks, deformation, former extent, correlation and summary. A good number of maps serve to guide the reader to the easy understanding of the several areas into which the formation is divided. I can only comment on a few of these subjects.

Professor Russell has done good service in the fourth headings in showing the incompleteness of the evidence on which glacial action has been argued as an agency in the deposition of the formation. Near the margin of several of the Newark areas, heavy conglomerates, containing boulders up to four or five feet in diameter, are known at various localities; and although none of these deposits are unstratified, they have frequently been appealed to as evidence of glacial action. But none of the boulders are scratched or notably angular; all of them are, as far as known, deposited near the shore of their time; all of them are systematically interbedded with ordinary aqueous deposits. Certainly they are not unaltered glacial deposits; and to assume that they are derived from such is to imply that no agency but glaciers is competent to move boulders of several feet in diameter. Russell refers to the occurrence of large angular rock masses on the alluvial fans of the arid regions at a distance of two or three miles from their source, to show that the movement of large boulders may take place under subaërial conditions; he cites the absence of ice-borne boulders among the finer strata of the Newark deposits; and he argues a relatively warm, not a cold climate, from the prevailingly red color of the formation and from the character of the fossils. Emerson has detected large boulders in certain basal beds of the sandstones in Northern Massachusetts, demonstrably close to their source, and not in the least indicative of glacial transportation. Indeed, to conclude that glacial action occurred at sea level during the period of Newark deposition simply from the coarse nature of certain marginal conglomerates, is to adopt an open alternative instead of a closed demonstration as a guide to belief.

Another line of evidence may be introduced against Fountaine's argument that the Newark conglomerates of Virginia were derived from glaciers which descended from the Appalachian mountains of that time. Local glaciers could originate in that latitude only on lofty mountains, from which they might descend to sea level, much as those of New Zealand do now. But the evidence gathered from the outline of the under border of the Newark areas does not at all favor the idea that they closely adjoined lofty mountains. If such had been the form of the surface whose submergence allowed the accumulation of the Newark sediments, their under border must have been extremely irregular; the Newark waters must have rounded many a bold promontory and penetrated many a deep bay. The basal sediments accumulated along so sinuous a water margin should now show some indication of these promontories and bays. They should be distributed much in the way that the Permian breccias of Wales lie around their once buried and now resurrected mountains, and thus show their origin on an extremely irregular coast. But as far as the basal beds of the Newark system have been studied out, they do not indicate that the surface on which they lie possessed any great relief at the time of their deposition. Whatever deformation it had previously suffered, whatever mountainous heights this deformation produced, the action of erosion had in pre-Newark time carried away enough material to some unknown goal to leave a surface of only moderate inequality; by no means of such inequality as would gather snow fields on its higher levels, and shed long glaciers down its valleys into the Piedmont seas.

The prevailing red color of the Newark strata is also adduced by Russell as indicative of a relatively warm climate, as contrasted to a glacial climate. To this might be added that the slow subaërial decay, from which red soils and sediments seem to be derived, is inconsistent with the conditions of decay on lofty mountains, from which the detritus is shed rapidly, leaving a relatively large surface of bare rocks; while it is accordant with the idea of a well denuded region, from which further denudation carries material slowly.

In examining the structural relations of the igneous rocks, it is noticeable that little success has as yet attended the efforts of observers southwest of the Delaware to distinguish between the intrusive and extrusive origin of their trap sheets. It would seem from this that the scouring of the decayed surface of the Newark belts by Pleistocene glacial action has been an advantage to the geologist of to-day in New Jersey, Connecticut and Massachusetts; but an advantage that is frequently offset by the sheets of drift which obscure or conceal so many of the weaker strata in the Connecticut valley. I believe that Connecticut alone has yielded a greater number of localities where the contact of the sandstones on the trap sheets can be actually seen, and from which good hand specimens can be secured, than all the areas beyond the Hudson. It may be noted that the map of the New York-Virginia Newark area, compiled by Russell from such data as he could gather together, does not give a correct impression of the crescentic trap ridges of eastern Pennsylvania. I have only examined a small part of that district, but from what was seen and from the topographic maps of the Perkiomen drainage area, surveyed by the Philadelphia water commissioners for a proposed new water supply, I think that an accurate geological map of the district will disclose a more systematic arrangement of forms than now appears.[1]

The deformation of the Newark areas has been a subject for much discussion already, and it will doubtless furnish as much more in the future. Before it can be successfully deciphered, the stratigraphic succession of the system must be made out; and that has not been generally done, as may be seen from Russell's chapter on lithology and stratigraphy; in which the various kinds of rocks are enumerated, but in which their succession and thickness is not stated. The difficulty of the problem lies in the monotony of the strata, and in the doubt in many cases as the origin of the trap sheets. Whatever success has yet been gained in solving this problem, it has come chiefly through the aid given by the old lava flows, and only secondarily through ordinary stratigraphic methods. In Pennsylvania and further south, no complete stratigraphic correlations have yet been established; mainly, as has has been stated above, because the trap sheets there are not yet well deciphered. In New Jersey the discrimination between intrusive and extrusive sheets has been well accomplished, but doubt is felt as to the location of fault lines by which they are dislocated, this doubt resulting from the uncertainty as to the reappearance of identical sandstone strata or trap flows. It is only in the Connecticut valley that the variety of trap sheets and associated sedimentary beds is such as to make the demonstration of faults complete. Here, over a considerable share of the area, the stratigraphic succession is made out with much certainty; and the lines of dislocation are determined with sufficient precision. At the same time certain fossiliferous beds, rare in the formation as a whole, and therefore of all the more value in defining horizons, have been traced for thirty or more miles inland from Long Island Sound; and their dislocations agreeably confirm the conclusions previously reached as to the faulting of the trap sheets.

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[1] Since writing the above, I have seen the new geological map of Pennsylvania, on which the curved trap sheets are clearly shown.

Like so many other features of this peculiar system of rocks, its style of deformation is exceptional. It is nowhere folded in the ordinary manner; where curvature of bedding appears, it is of such character as to give crescentic outlines to the beveled edges of the strata now visible. The formation is, as a rule, tilted over to a rather regular monoclinal attitude; but while the earlier conceptions of its structure implied that the monocline was practically uninterrupted, the later studies show it to be complicated by numerous faults, traversing the mass in various directions, and as a rule systematically arranged, although the control of the system is obscure. One thing is clear: the faults penetrate the crystalline foundation on which the Newark beds lie; they are not dislocations within the Newark beds alone; indeed, it almost seems fair to say that the dislocating forces were indifferent to the cover of Newark beds, and that their action was chiefly expended on a much deeper mass of rocks

The original extent of the Newark areas has been much discussed, and Mr. Russell, some years ago, espoused the idea that their present surface was a comparatively small part of their original basins. This matter is essentially indeterminate at present; but the valid evidence of great post-Newark erosion disposes me to accept almost any measure of former extension of the system that may be required by reasonable argument. At first, the mind halts before the supposition that vast masses have been uplifted and worn away in the ages since the date of the Newark deposition, but the evidence of vast denudation in that interval is now so complete that it no longer seems warrantable to withhold belief in the "broad terrane hypothesis," either from its extravagant erosion of rock masses, or from an apparent insufficiency of time for such extravagance.

On the other hand, while it seems likely that there was some connection between the several separate Newark areas, because their fauna and flora are so similar, it does not seem necessary to conclude that all the space between the Connecticut and the New Jersey areas was once overspread by Newark strata. It may have been. There was time enough during the Newark deposition to furnish material for such a cover; and there has been time enough since then to wear it away; but still there is no direct evidence that it existed. The original boundaries of the formation are very vaguely defined.

Noticing that a greater definiteness of results has been gained in the Connecticut valley than in the other Newark areas, it is evident that the physical conditions of origin of the trap sheets in the southern areas deserve the closest scrutiny. If they prove to be intrusive sheets, they are of little structural value. But if they are proved to be extrusive, they may then be treated as conformable members of the stratified series, and thus a key to the general attitude of the system is gained. After this step, the detection of sequences of strata, including extrusive trap sheets with the aqueous sediments, is of next importance, as by this means faults may be located, and thus some advance made in the general reconstruction of the formation.

But even where best studied out, it is likely that the cross sections by which underground structure is represented are hardly more than parodies on the facts; so insufficient are the opportunities for the discovery of deep internal structures. A close knowledge of the system seems beyond reasonable expectation.

W. M. DAVIS.

HARVARD COLLEGE, November, 1893.